

20.—NOTES ON THE BOTANY OF THE EXPERIMENTAL GRASS PLOTS
AT ROTHAMSTED, HERTFORDSHIRE.

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AMONG the numerous experiments conducted at Rothamsted by Messrs. Lawes and Gilbert, there are none more interesting, certainly not to the botanist, than those made on permanent meadow land, because, independently of their value in practical agriculture, they afford great facilities for the study of botany in all its various branches. Our meadow lands comprise, as is well known to botanists, not only a great number of genera and species belonging to the grass family—the natural order Graminaceæ—but also various members of other families of plants.

In the year 1856 Mr. Lawes set apart about eight acres of grass land in his park at Rothamsted, for the purpose of investigating the comparative effects of different manuring substances upon permanent grass; in the first instance probably to determine the best means of increasing the gross amount of produce. But not only has the general character of the herbage as to vigour, colour, date of ripening, etc., materially altered, but the composition of the produce has been entirely changed under this treatment. The portion of land selected by Mr. Lawes for these experiments is composed of a heavy loam, with a red clay subsoil of several feet in depth immediately overlying the Chalk; and it has probably been laid down with grass for some centuries. No fresh seed has been artificially sown within the last fifty years certainly, nor is there a record of any having been sown since the grass was first laid down. As previously stated, the experiments commenced in the year 1856, at which time the character of the herbage appeared uniform over all the plots. The portion of ground was divided into twenty plots of from a quarter to half an acre each, and in most cases the same description of manure has been applied year after year to the same space of ground, two pieces being left as test plots and entirely unmanured; and the results, which have been fully and carefully noted, are very extraordinary.

Besides weighing the produce obtained by the different manures as hay, and taking samples for the determination of its chemical composition—namely, dry matter, ash, nitrogen, woody fibre, fatty matter, etc.—carefully averaged samples are taken in each fifth year from all the plots, and every year from selected plots, and submitted to careful botanical separation, the per-centages by weight of each species in the mixed herbage being determined. This is necessarily a most tedious and lengthy proceeding, occupying a period of several months in the laboratory, and requiring considerable skill at the identifications—a labour which appears to present

insurmountable difficulties, but with a little practice is easily accomplished. Sharp lads of about fourteen years of age soon learn (of course, under special training) to distinguish most of the species, even to the smallest fragments of the leaves of any of the grasses. The characters of the leaves of the plants are various, and are found in their texture, surface, colour, point, ligule, mode of curling or folding together when dry, nature of the margin, hairiness, relative prominence of the midrib, etc. By one or more of these characters it is possible to distinguish almost any piece, however small.

In the Laboratory at Harpenden is to be seen by the visitor a large upright wall-case, which shows the botanical composition of the herbage on seven selected plots in the twelfth year of the experiments (1867); and at the South Kensington Museum is one contributed by Mr. Lawes, showing the composition in twelve selected plots in the seventeenth year (1872). The quantities of the different plants there exhibited represent the relative proportion by weight in which each species was found; and the whole illustrates in a striking manner the domination of one plant over another, under the influence of the different manures applied.

The general results of the experiments may be briefly summarised as follows:—

The mean produce of hay per acre, per annum, has ranged on the different plots from about 21 cwt. without manure, to about 63 cwt. on the plot most heavily manured.

The number of species found has generally been about 50 on the unmanured plot, where there is no marked predominance of one plant over another; and has been reduced to an average of only 20 on the plot most heavily manured, where the effect is to stimulate some of the coarser growing grasses, and other plants, to extraordinary growth, and crowd out or otherwise cause to disappear the more weakly species; and it may be stated as a rule that whatever the description of manure employed, any considerable increase of crop is accompanied by greater simplicity of herbage.

Species belonging to the order Graminaceæ have on the average contributed about 68 per cent. of the weight of the mixed herbage grown without manure, about 65 per cent. of that grown with purely mineral manure (consisting of salts of potash, soda, magnesia, and super-phosphate of lime), and about 94 per cent. of that produced with the same mineral manure with a large quantity of ammonia-salts in addition.

Species of the order Leguminosæ have, on the average, contributed about 9 per cent. of the produce without manure, about 20 per cent. of that with purely mineral manure, and less than 0.01 per cent. of that with the mixture of the same minerals and a large quantity of ammonia-salts.

Species belonging to various other orders have, on the average, contributed about 23 per cent. of the produce without manure, about 15 per cent. of that with mineral manure, and only about 6 per cent. of that with the mixture of minerals and ammonia-salts.

The struggle for existence which is going on between plant and plant may be illustrated by a comparison of the per-centages of a few grasses on the unmanured and the most highly manured plots.

	Unmanured.	Highly Manured.
<i>Alopecurus pratensis</i>	0·52 per cent.	12·35
<i>Anthoxanthum odoratum</i>	5·20 „ „	0·78
<i>Avena flavescens</i>	3·49 „ „	0·09
„ <i>pubescens</i>	3·55 „ „	0·00
<i>Briza media</i>	6·40 „ „	0·00
<i>Cynosurus cristatus</i>	1·11 „ „	0·00
<i>Dactylis glomerata</i>	0·90 „ „	39·28
<i>Festuca ovina</i>	21·67 „ „	0·38
„ <i>pratensis</i>	0·13 „ „	10·41
<i>Poa pratensis</i>	0·09 „ „	10·40

The complete Flora of the experimental plots may be summarised as follows:—

Total number of species	93
„ „ genera	67
„ „ orders	23
Number of species of Acotyledons.....	15
„ „ Monocotyledons	24
„ „ Dicotyledons	54

Amongst these are several species not commonly met with on meadow land,—such, for instance, as *Ranunculus auricomus*, *Vicia Cracca*, *Vicia sepium*, *Galium Aparine*, *Sonchus oleraceus*, *Fritillaria meleagris*, *Trifolium procumbens*, and *Ornithogalum umbellatum*. But these are only represented by a few individuals, and form no appreciable proportion of the crop. Amongst the acotyledons are included eleven species of Fungi found on the various plots. One fern, *Ophioglossum vulgatum*, and three species of mosses, *Hypnum squarrosum*, *H. rutabulum*, and *H. hians*, are also met with.

In the many points of interest brought out in these investigations it is found that even plants of the same genera differ so materially in their character and habit of growth, that, when in association with each other and with other plants, and subject to a great variety of conditions as to manure, they comport themselves in the struggle very differently. In order to gain further information respecting this subject, samples of the soil from all the experimental plots have been taken, to a depth of five feet, and the roots have been separated and carefully noted upon.

In conclusion, it may be mentioned that Messrs. Lawes and Gilbert have now in preparation a full report on the results of these experiments, in which the whole subject will be most exhaustively treated.